SECTION 714 -- MECHANICALLY STABILIZED EARTH (MSE) WALLS WITH CONCRETE FACING PANELS

714.01 -- Description

1. This work shall consist of designing, furnishing materials, and constructing mechanically stabilized earth (MSE) walls with concrete facing panels in accordance with these *Specifications* and with the lines, grades, dimensions, and details shown in the plans.

2. The MSE walls shall consist of a nonstructural leveling pad, concrete face panels, and soil reinforcement elements mechanically connected to each facing panel. Soil reinforcement shall have sufficient strength, frictional resistance, and length as required by the design and as outlined in these *Specifications.*

3. The approved proprietary mechanically stabilized earth retaining wall systems are shown in the plans. Approved suppliers are shown on the Department's "Approved Products List".

4. All appurtenances behind, in front of, under, mounted upon, or passing through the wall, such as drainage structures, utilities, or other appurtenances shown in the plans, shall be accounted for in the stability design of the wall.

5. The MSE wall design shall follow the general dimensions of the wall envelope shown in the plans. The plans will locate the theoretical leveling pad elevation. The minimum wall embedment below the finished ground surface shall be 1 foot or as shown in the plans. The top of the face panels shall be at or above the top of the panel elevation shown in the plans. Where coping or barrier are used, the wall face panel shall extend up into the coping or barrier a minimum of 2 inches. The top of the face panels may be level or sloped to meet the top of the wall line noted. Cast-in-place concrete will be allowed for minor grouting of pipe penetrations and leveling required for coping or traffic barrier. The mechanical wall height for the purposes of design calculations shall be from the top of the leveling pad to the top of the ground surface where the potential failure surface intercepts the ground surface.

6. Where walls or wall sections intersect with an angle of 130 degrees or less, a special vertical corner element panel shall be used. The corner element panel shall cover the joint of the panels that abut the corner and allow for independent movement of the abutting panels. Corner elements shall not be formed by connecting standard facing panels that abut the acute corner.

7. The face panels shall be designed to accommodate differential settlements along the length of the wall and normal to the wall alignment. Differential settlements along the length of the wall shall not exceed 1.0 foot per 100 feet of wall length. When the expected differential settlements normal to the wall exceed 3 inches, the lower level reinforcement facing connections shall be designed to accommodate the increased tensile forces due to the settlement. Where shown in the plans, or determined by the MSE wall supplier, vertical joints to accommodate excessive differential settlement shall be included.

8. Working Drawings and Shop Drawings:

   a. The Contractor shall submit to the Engineer for review:

      (1) 6 sets of working drawings and shop drawings.

(2) 6 sets of design calculations.

(3) Explanatory notes.

(4) Specifications.

(5) Proposed component materials for the wall system.

b. The shop drawings and design calculations shall be signed, sealed, and dated by a Professional Engineer registered in Nebraska.

c. These drawings shall include a numbered panel layout for fabrication and erection purposes, as well as for any required coping when it is prefabricated.

d. They shall further include the horizontal and vertical alignment of the walls as well as the existing and proposed ground lines, all as shown in the plans.

e. The drawings will also reflect:

(1) All information needed to fabricate and erect the walls including the proposed leveling pad elevations.

(2) The shape and dimensions of panels.

(3) The size, number, and details of the reinforcing steel.

(4) The number, size, type, and details of the soil reinforcing system and anchorage.

(5) The size, details, and manufacturer of all fillers and filter cloth.

(6) The size of leveling pad.

(7) The dimensions of structural backfill required.

(8) Any additional details pertaining to coping, railing, drainage, or electrical conduit required by the contract plans.

f. Leveling pad elevations may vary from footing elevations shown in the plans. However, the leveling pad elevations shall be such as to allow for transverse and longitudinal drainage structures shown in the plans and shall provide 2 foot minimum cover from the top of the leveling pad to finish grade.

g. (1) The Contractor shall not start work on any earth retaining system until the shop drawings and working drawings are reviewed and returned by the Engineer.

(2) It is expressly understood that the review of the Contractor's drawings shall not relieve the Contractor of any responsibility under the contract for the successful completion of the work in conformity with the requirements of the plans and specifications.

(3) The Contractor shall allow 30 calendar days for the review of the drawings by the Engineer.

9. Design Requirements:

a. (1) The design, by the wall system supplier, shall consider the internal stability of the wall's retained mass. In conjunction with these *Specifications,* the following publications shall be used by the wall system supplier when designing the wall system:

(i) *Reinforced Soil Structures Volume I. Design and Construction Guidelines* FHWA-RD-89-043, (Chapter 3);

(ii) AASHTO's *Standard Specifications for Highway Bridges,* (Division 1, Section 5 and Division II, Section 7);

(iii) *Design Manual for Segmental Retaining Walls National Concrete Masonry Association,* Washington, D.C.

(2) The Contractor is solely responsible for the satisfactory construction and performance of the wall and the internal stability of the wall's retained mass. The Contractor shall submit certification that the wall is designed in accordance with the current AASHTO Standard Specifications for Highway Bridges.

b. The Engineer shall indicate in the contract plans the "external site factors" which include:

(1) Settlement both along and perpendicular to the MSE structure alignment.

(2) Allowable bearing capacity of the foundation soil.

(3) External drainage beneath and behind the MSE volume.

(4) The design parameters for the foundation soils.

c. The theoretical failure plane within the reinforced soil mass shall be analyzed so that the soil stabilizing components extend sufficiently beyond the failure plane to stabilize the material. At a minimum, the theoretical failure plane, the structure's mechanical height, and the effective reinforcement pullout length shall be at least as conservative as shown in Figure 5.8.4.1A of AASHTO's *Standard Specifications for Highway Bridges*, (Division I, Section 5). External loads which affect the internal stability, such as those applied through piling, bridge footings, traffic, slope surcharge, and hydrostatic and seismic loads, shall be accounted for in the design.

d. When a highwater surface elevation is shown in the plans at the wall face, the design stresses calculated from that elevation to the bottom of the wall must include a minimum differential hydrostatic pressure equal to 40 inches of water. This buoyant force from the saturated soil shall be used to calculate internal stability, including pullout resistance.

e. The friction angle of the select backfill used in the reinforced fill zone for the internal stability design of the wall shall be 34 degrees unless shown otherwise in the plans. Before construction begins, the selected backfill shall be subject to approval to show conformance with this frictional requirement. The approval shall be based on the results of the standard direct shear test, AASHTO T 236, utilizing a sample of the material compacted to 95 percent maximum density as determined by AASHTO T 99, at optimum moisture content. Compliance with the test requirements shall be the

responsibility of the Contractor. The wall supplier shall be furnished a copy of the test results before construction. The friction angle of the foundation soils and random backfill shall be 30 degrees unless otherwise shown in the plans.

(1) The optimum moisture content shall be determined in accordance with AASHTO T 99 based on a minimum of 4 percent moisture content.

f. The safety factors for external stability are:

(1) 1.5 for pullout based in pullout resistance at 3/4 inch deformation for a representative backfill.

(2) 1.5 for sliding.

(3) 2.0 for overturning.

(4) 2.0 for panel connection pullout or rupture at the design life for the maximum allowable reinforcement tension.

g. All structural connections shall be subject to the same metal loss rates and allowable tension requirements as outlined in Paragraph 9.j. of this Subsection.

h. The soil reinforcement shall be the same length from the bottom to the top of the wall. The reinforcement length defining the width of the entire reinforced soil mass may vary with wall height. The minimum length of the soil reinforcement shall be 0.7H for walls with level surcharges, or $0.7H_1$ for walls with a sloped surcharge or supporting an abutment. The mechanical height, H_1, shall be the vertical difference between the leveling pad and the elevation at which the failure surface, as described above, intercepts the ground surface supported by the wall.

i. State of Stress and Pullout Resistance:

(1) The lateral earth pressure to be resisted by the reinforcements shall be calculated using the appropriate coefficient of earth pressure, K, based on the type of reinforcement used, multiplied by the vertical soil stress at each reinforcement layer.

(2) The soil reinforcement length shall be sufficient to satisfy the above requirements, sliding, overturning and pullout factors of safety, and the minimum lengths required for external stability.

(3) For ribbed reinforcing strips, the maximum apparent coefficient of friction, f*, shall be as shown in Table 714.01.

Table 714.01

Maximum Coefficient of Friction	
Uniformity Coefficient (C_u) of Select Granular Backfill	**Maximum f***
Less than 2	1.2
2 to 7	1.5
More than 7	2.0

(4) The maximum values shown in Table 714.01 will be used at the top of the structure and will vary to a value of the tangent of ø at a depth of 20 feet, and it will remain constant (at tangent of ø) below a depth of 20 feet. A maximum f* value of 2.0 is justified when using crushed stone backfill with a uniformity coefficient below 7.

(5) For wire mesh or bar mat reinforcement, the maximum anchorage factor, A_c, shall be 30 at the top of the structure and vary to 15 at a depth of 20 feet, and it will remain constant at 15 below a depth of 20 feet. The calculation of pullout resistance for wire mesh reinforcement shall be calculated using the diameter of transverse bars remaining at the end of the service life after applying the corrosion rates given in Paragraph 9.j. of this Subsection.

(6) The top of the structure is established as the elevation at the upper limit of the mechanical height, H_1.

(7) Passive pressure in front of the wall mass shall be assumed to be zero for design purposes. Calculations for stresses and factors of safety shall be based on assumed conditions at the end of the design life. Design life shall be 75 years unless otherwise indicated in the plans.

j. (1) For steel reinforcements, including tie strips and loop inserts, the metal loss rates shown in Table 714.02 shall be assumed.

Table 714.02

Metal Loss Rates	
Metal	**Rate**
Zinc (first 2 years):	15 µm/year/side
Zinc (subsequent years to depletion):	4 µm/year/side
Carbon Steel (after depletion of zinc):	12 µm/year/side
Carbon Steel (75 to 100 years):	7 µm/year/side

(2) The allowable tensile stress in steel reinforcement and connections including tie strips and loop inserts, F^t, at the end of the service life, shall conform to the following:

(i) Systems using linear reinforcement (strips):

[1] $F^t = 0.55\ F_y$ at the reduced gross section (minimum cross section).

[2] $F^t = 0.50\ F_u$ at the net section at a bolt hole (applicable to bolted connections only).

(ii) Systems with bar mats or welded wire mesh:

$F^t = 0.47\ F_y$ at all sections.

(3) F_y used for design shall not exceed 65,000 psi. Maximum allowable tension in reinforcements shall consider any reduction in cross sectional area of reinforcement due to punching and corrosion losses and shall not exceed 50 percent of pullout capacity of the connection devices embedded in facing panels.

714.02 -- Material Requirements

1. The Contractor shall make arrangements to purchase the material covered by this Section of the *Specifications*, including concrete panels, reinforcing mesh or strips, attachment devices, fasteners, joint materials, and all necessary incidentals from the wall system supplier which the Contractor based his/her bid on. The supplier shall furnish the Engineer a Certificate of Compliance certifying that the applicable materials comply with Section 714 of the *Specifications*. Materials not conforming to Section 714 of the *Specifications* shall not be used.

2. a. Concrete facing panels shall have a minimum thickness of 5 1/2 inches and a minimum concrete cover on reinforcing steel of 1 1/2 inches. Cement shall be Types I, II, or III and shall conform to the requirements of AASHTO M 85. Concrete shall have a compressive strength at 28 days as prescribed in this Subsection. Additives containing chloride shall not be used without the approval of the Engineer. Attachment devices, connecting pins, PVC pipe, and lifting devices shall be set in place to the dimensions and tolerances shown on the shop plans and called out in these *Specifications* before casting.

b. Testing and Inspection: Acceptability of the precast units shall be determined on the basis of compressive strength tests and visual inspection. The precast units shall be considered acceptable regardless of curing age when compressive strength test results indicate that the compressive strength will conform to the 28-day requirements. The Contractor or supplier shall furnish facilities and perform all necessary sampling and testing in an expeditious and satisfactory manner. Panels utilizing Type I or II cement shall be considered acceptable for placement in the wall when the 7-day initial strength equals or exceeds 85 percent of the 28-day strength (4,350 psi).

c. Casting: The panels shall be cast face down in level forms supported on a flat working surface. Guides shall be used to locate and support attachment devices set in the back face of the panel. The concrete in each panel unit shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corners of the forms and to prevent the formation of rock pockets or cleavage planes. The same type of clear form oil or release agent shall be used throughout the casting operation.

d. Curing: The units shall be cured for a sufficient length of time so that the concrete will develop the specified compressive strength.

e. Removal of Forms: The forms shall remain in place until they can be removed without damage to the units.

f. Concrete Finish: Unless otherwise indicated in the plans or elsewhere in the specifications, the concrete surface for the front face shall have an ordinary steel form finish; and for the rear face, an unformed finish. The rear face of the panel shall be free of open pockets of aggregate and surface distortions in excess of 0.25 inch.

g. Tolerances: All units shall be manufactured within the following tolerances with respect to the dimensions shown in the shop plans:

(1) Attachment Device Locations and Alignment -- Lateral position of reinforcing strip attachment devices shall be within 1 inch. Embedment measured from the back face of the panel shall be within 0.25 inch and -.050 inch. Bearing surfaces of multiple attachment points for a single soil reinforcing element shall align within 0.0625 inch.

(2) Panel Dimensions -- All panel dimensions shall be within 0.25 inch. All hardware embedded in the panel, with the exception of attachment devices, shall be within 0.25 inch.

(3) Panel Squareness -- Squareness, as determined by the difference between the 2 diagonals, shall not exceed 0.50 inch.

(4) Panel Surface Finish -- Surface defects on smooth-formed surfaces, measured on a length of 5 feet, shall not exceed 0.25 inch. Surface defects on textured-finished surfaces, measured on a length of 5 feet, shall not exceed 0.3125 inch.

h. Compressive Strength: Acceptance of the concrete panels, with respect to compressive strength, shall be determined on the basis of production lots. A production lot is defined as a group of panels that shall be represented by a single set of compressive strength samples and shall consist of not more than 80 panels or a single day's production, whichever is less.

i. Compressive strength tests shall be performed on 6 inch diameter by 12 inch cylinders prepared in accordance with AASHTO T 23. During the production of the concrete panels, the manufacturer shall randomly sample the concrete in accordance with AASHTO T 141. A single set of compressive strength samples, consisting of a minimum of 4 cylinders, shall be made for every production lot.

j. For every compressive strength sample, a minimum of 2 cylinders shall be cured in the same manner as the panels and tested at 7 days. The average compressive strength of these cylinders, when tested in accordance with AASHTO T 22, will determine the initial strength of the concrete. In addition, a minimum of 2 cylinders shall be cured in accordance with AASHTO T 23 and tested at 28 days. The average compressive strength of these cylinders, when tested in accordance with AASHTO T 22, will determine the compressive strength of the production lot.

k. If the initial strength test results indicates a compressive strength greater than or equal to 4,350 psi, then this test result will be utilized as the compressive strength test result for that production lot and the requirement for testing at 28 days will be waived for that particular production lot.

l. Acceptance of a production lot will be made if the 28-day compressive strength test result is greater than or equal to 4,350 psi. If the 28-day compressive strength test result is less than 4,350 psi, the acceptance of the production lot will be based on its meeting the following acceptance criteria in its entirety:

(1) 90 percent of the compressive strength test results for all of the production lots shall exceed 4,150 psi.

(2) The average of any 6 consecutive compressive strength test results, including the one in question, shall exceed 4,250 psi.

(3) No individual compressive strength test result shall fall below 4,350 psi.

m. The date of manufacture, the production lot number, and the structure component shall be clearly indicated on each cylinder.

n. (1) All units shall be handled, stored, and shipped in such a manner as to minimize the danger of chipping, cracks, fractures, and excessive bending stresses.

(2) Panels shall be stored and shipped in stacks, front face down.

(3) Firm blocking of sufficient thickness to prevent damage to the stacked panels shall be provided.

(4) Lifting inserts shall be installed on the top edge of the precast panels to allow lifting at the project site.

(5) Reinforcement connection inserts (tie strips or loop inserts) shall not be used for lifting or handling the panel.

o. Acceptance Criteria: Units shall be subject to rejection because of failure to meet any of the requirements specified above. In addition, any or all of the following defects may be sufficient cause for rejection:

(1) Defects that indicate imperfect molding.

(2) Defects indicating honeycombed or open-texture concrete.

(3) Defects in the physical characteristics of the concrete, such as broken or chipped concrete.

p. (1) The Engineer shall determine whether spalled, honeycombed, chipped, or otherwise defective concrete shall be repaired or be cause for rejection.

(2) Repair of concrete, if allowed, shall be done in a manner satisfactory to the Engineer.

(3) Repair to concrete surfaces which will be exposed to view after completion of construction must be approved by the Engineer.

3. a. All reinforcing and attachment devices shall be carefully inspected to insure they are true to size and free from defects that may impair their strength and durability.

b. Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to either ASTM A 36/A 36M or ASTM A 572/A 572M Grade 65 or equal. Galvanization shall conform to the minimum requirements of ASTM A 123.

c. Reinforcing mesh and bar mats shall be shop fabricated from cold drawn steel wire conforming to the minimum requirements of ASTM A 82 and welded into the finished mesh fabric in accordance with ASTM A 185. Galvanization shall be applied after the mesh is fabricated and conform to the minimum requirements of ASTM A 153 or ASTM A 123.

d. The tie strips shall be shop fabricated from hot rolled steel conforming to the minimum requirements of ASTM A 570/A 570M, Grade 50 or equivalent. Galvanization shall conform to ASTM A 123.

e. Fasteners shall consist of hexagonal cap screw bolts and nuts which are galvanized and conform to the requirements of ASTM A 325M (AASHTO M 164) or equivalent.

f. Connector bars and pins shall be fabricated from cold drawn steel wire conforming to the requirements of ASTM A 82 and be galvanized in accordance with ASTM A 123.

g. Structural plate connectors and fasteners used for yokes to connect reinforcements to wall panels around pile or utility conflicts shall conform to the material requirements for reinforcing strips and fasteners in Paragraphs 3.a. and 3.d. of this Subsection.

4. a. Joint materials shall be installed to the dimensions and thicknesses shown and in accordance with the plans or reviewed shop plans.

b. Bearing pads shall have a durometer hardness of 80 ± 5.

c. Where required, as shown in the plans, horizontal and vertical joints between panels shall be covered by a geotextile. The geotextile may be either a non-woven needle punched polyester geotextile or a woven monofilament polypropylene geotextile as approved by the wall supplier. Adhesive used to hold the geotextile filter fabric material to the rear of the facing panels before backfill placement shall be approved by the wall supplier.

5. a. The select granular backfill material used in the MSE structure shall be reasonably free from organic and otherwise deleterious materials and shall conform to the gradation limits as determined by AASHTO T 27 and shown in Table 714.03.

Table 714.03

Facing Panel Select Granular Backfill Gradation	
Sieve Size	**Percent Passing**
3/4 inch	100
No. 200	0 to 15

b. In addition, the backfill shall conform to all of the following requirements:

(1) The Plasticity Index (P.I.), as determined by AASHTO T 90, shall not exceed 6.

(2) The material shall be substantially free of shale or other soft, poor durability particles. The material shall have a sodium sulfate soundness loss of less than 30 percent after 5 cycles, as determined by AASHTO T 104.

(3) The backfill material shall conform to the electrochemical requirements in Table 714.04.

Table 714.04

Electrochemical Requirements		
Property	**Requirement**	**Test Method**
Resistivity	Minimum 3000 ohm-cm, at 100% saturation	NDR T 25
ph	Acceptable Range 5 - 10	NDR T 24
Chlorides	Maximum 100 ppm	ASTM D 512
Sulfates	Maximum 200 ppm	ASTM D 516

(4) Chloride and sulfate content shall be determined by the indicated ASTM test method. However, in each method, the select granular backfill material shall be prepared for testing by first accomplishing the following extraction procedure: Dry the sample material in an oven at 100°F for 8 hours. Measure 100 g of the material and transfer to a 500 mL Erlenmeyer flask. Add 300 mL of distilled water and shake the mixture for 5 minutes. Repeat the shaking after 1 hour. Allow the mixture to settle for 8 hours. Vacuum filter the liquid layer through a filter apparatus containing a No. 42 Whatman filter paper. Pour the remaining solid material into the filter paper without the use of an additional water rinse. Reserve the filtrate for testing.

(5) The material, when compacted to 95 percent of maximum density, as determined by AASHTO T 99, at optimum moisture content, based on a minimum of 4 percent moisture content, shall exhibit an angle of internal friction of not less than 34 degrees as determined in a standard direct shear test (AASHTO T 236).

c. The frequency of sampling of select granular backfill necessary to assure gradation control throughout construction shall be as directed by the Engineer. The Contractor shall furnish to the Engineer a Certificate of Compliance certifying that the select granular backfill material complies with this Section of the *Specifications*.

d. A copy of all test results performed by the Contractor, which include: AASHTO T 27; AASHTO T 90; AASHTO T 104; ASTM G 51; ASTM G 57; ASTM D 512; ASTM D 516; AASHTO T 99 and AASHTO T 236, shall also be furnished to the Engineer.

e. Backfill material not conforming to this *Specification* shall not be used without the written consent of both the Engineer and the wall supplier.

714.03 -- Construction Methods

1. Excavation shall be in accordance with the requirements of the plans and specifications.

2. The foundation for the structure shall be graded level for a width equal to or exceeding the length of the soil reinforcement, or as shown in the plans. Before wall construction, the foundation, if not in rock, shall be compacted in accordance with Subsection 205.03. Any foundation soils found to be unsuitable shall be removed and replaced as directed by the Engineer. At each panel foundation level, an unreinforced concrete leveling pad shall be provided as shown in the plans. The leveling pad shall have nominal dimensions of 6 inch thickness and 12 inch width and shall be cast using concrete which achieves 2,175 psi in 28 days. The leveling pad shall be cast

to the design elevations shown on the working drawings. Allowable elevation tolerances are + 0.125 inch and - 0.25 inch from the design elevation. The leveling pad shall be cured a minimum of 24 hours before placement of wall panels.

3. Precast concrete panels shall be placed in the vertical orientation as shown in the working drawings. For erection, panels shall be handled by means of lifting devices set into the upper edge of the panels. Panels shall be placed in successive horizontal lifts in the sequence shown in the plans as backfill placement proceeds. As backfill material is placed behind the panels, the vertical panel joints shall be maintained in a plumb position by means of temporary wooden wedges placed in the joint at the junction of the 2 adjacent panels on the external side of the wall. External bracing is required for the initial lift. Vertical tolerances (plumbness) and horizontal alignment tolerances for any one panel shall not exceed 0.75 inch. The allowable panel joint gap shall not exceed 0.75 inch. The overall vertical tolerance of the wall (plumbness from top to bottom) shall not exceed 0.75 inch per 10 feet of wall height.

4. a. Before placing the first layer of reinforcements (strips or mats), backfill shall be placed and compacted.

b. Bending of reinforcements in the horizontal plane that results in a permanent deformation in their alignment shall not be allowed.

c. Connections of reinforcement to piles or bending of reinforcements around piles shall not be allowed. Cutting of longitudinal or transverse reinforcement bars to avoid conflicts with piles or utility obstructions shall not be allowed.

d. A structural connection (yoke) from the wall panel to the reinforcement shall be used whenever it is necessary to avoid cutting or excessive skewing of reinforcements due to pile or utility conflicts.

e. Soil reinforcements shall be placed normal to the face of the wall, unless otherwise shown in the plans or directed by the Engineer. If skewing of the soil reinforcements is required due to obstructions in the reinforced fill, rotatable bolted connections shall be used and the maximum skew angle shall not exceed 15 degrees from the normal position except in the case of acute corners where redundant reinforcements are used.

5. a. Backfill placement shall closely follow erection of each course of panels.

b. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials or misalignment of the facing panels.

c. Any wall elements which become damaged or disturbed during backfill placement shall be either removed and/or replaced by the Contractor at no additional cost to the Department.

d. Any backfill material placed within the reinforced soil mass which does not meet these *Specifications* shall be either removed and/or replaced by the Contractor at no additional cost to the Department.

e. Backfill shall be compacted to 95 percent of the maximum density as determined by AASHTO T 99.

f. The moisture content of the backfill material before and during compaction shall be uniform throughout each layer.

g. Backfill material shall have a placement moisture content less than or equal to the optimum moisture content.

h. Backfill material with a placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniform and acceptable throughout the entire lift.

i. The optimum moisture content shall be determined in accordance with AASHTO T 99 based on a minimum of 4 percent moisture content.

j. The frequency of sampling of the backfill material necessary to assure gradation control throughout construction shall be as directed by the Engineer.

k. The maximum lift thickness after compaction shall not exceed 10 inches, regardless of the vertical spacing between layers of soil reinforcements. The Contractor shall decrease this lift thickness, if necessary, to obtain the specified density.

l. Before placement of the soil reinforcements, the backfill elevation, after compaction, shall be 2 inches above the attachment device elevation from a point approximately 1 foot behind the back face of the panels to the free end of the soil reinforcements, unless otherwise shown in the plans.

m. Compaction within 40 inches of the back face of the panels shall be achieved by at least 3 passes of a lightweight mechanical tamper, roller, or vibratory system. The specified lift thickness shall be adjusted as warranted by the type of compaction equipment actually used, but no soil density tests need be taken in this area.

n. Care shall be exercised in the compaction process to avoid misalignment of the panels or damage to the attachment devices. Heavy compaction equipment shall not be used to compact backfill within 40 inches of the wall face.

o. At the end of each day's operation, the Contractor shall slope the last level of backfill away from the wall facing to direct runoff of rainwater away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

6. When shoring for phased construction is shown in the plans, the Contractor shall design and install the shoring. The type of shoring used shall be determined by the Contractor. Design calculations for the shoring shall be prepared by a Professional Engineer registered in the State of Nebraska. Before construction begins, 4 sets of the calculations and shoring plans shall be submitted to the NDR Construction Division for informational purposes only. The Contractor is solely responsible for the construction and performance of the shoring. All shoring shall remain in place and not extend more than 2 feet below finished grade.

714.04 -- Method of Measurement

1. The quantity of concrete face panels is measured by the square foot and is computed using the plan dimensions. No adjustment in the pay quantity will be made if the computed quantity, based on the working drawings, varies from the plan quantity. The wall surface area, as shown on the plans, includes the surface area of nominal panel joint openings and wall penetrations such as pipes and other utilities.

2. The quantity of concrete leveling pads shall be measured by the foot and is computed using the plan dimensions. No adjustment in the pay quantity will be made if the computed quantity, based on the working drawings, varies from the plan quantity.

3. The quantity of “Select Granular Backfill for MSE Walls" is measured by the cubic yard and computed using the plan dimensions. No adjustment in the pay quantity will be made if the computed quantity, based on the working drawings, varies from the plan quantity. The quantity shown in the plans is based on a volume equal to the height of the wall times the length of the wall times a width equal to 70 percent of the height.

4. The quantity of "Coping" is measured by the linear foot and is computed using the plan dimensions. No adjustment in the pay quantity will be made if the computed quantity, based on the working drawings, varies from the plan quantity. The coping quantity shall be based on the coping cross-section shown in the plans.

5. "Shoring For Mechanically Stabilized Earth Structures" is measured by the lump sum. Items that are included in the lump sum price are the shoring design, plan preparation and submittals, and all labor, materials, and equipment necessary to construct the shoring.

714.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Concrete Face Panels	Square Foot (SF)
Concrete Leveling Pads	Linear Foot (LF)
Select Granular Backfill for MSE Walls	Cubic Yard (CY)
Coping	Linear Foot (LF)
Shoring For Mechanically Stabilized Earth Structures	Lump Sum (LS)

2. Excavation for the leveling pads will not be measured and paid for separately, but shall be subsidiary to the appropriate pay item requiring the excavation.

3. Payment is full compensation for all work prescribed in this Section.

4. Construction of the V-ditch shown on the plans at the top of wall is subsidiary to the pay item “Coping”.